Research Paper

The Anatomy Study of the Facial Temporal Region, Age 25–50, in Thai Population Based on Ultrasound Investigation

Chenda Ly[1], Chantawat Kasemnet[1], Thamthiwat Nararatwanchai[1], Tawee Saiwichai[2], Somboon Roongphornchai[1], Sirintip Chaichalotornkul[1]*

[1] Mae Fah Luang University, Thailand
[2] Mahidol University, Thailand

Received : February 19, 2025	Revised : June 19, 2025	Accepted : June 21, 2025	Online : June 30, 2025

Abstract

Aging affects facial tissues, including skin, fat, muscles, and bones, with the temporal region playing a crucial role in both function and appearance. Temporal depression contributes to an aged look, increasing demand for aesthetic procedures. However, the complex layered structure and vascular pathways present challenges for safe interventions in this region. This study utilized high-frequency ultrasound to map the depth and position of the deep temporal arteries and assess the anatomy of the temporal region in Thai individuals aged 25–50 years. The observational cross-sectional design included 33 participants (15.15% male, 84.85% female) with an average age of 33.42 years. High-frequency ultrasound was used to evaluate the soft tissue and artery positioning. The sample included 10 individuals with and 23 individuals without hyaluronic acid filler injections. Significant differences in skin thickness, subcutaneous layers, SMAS layers, temporalis muscle thickness, and temporal bone characteristics were observed between the two groups. Filler injections notably altered anatomical structures, affecting artery depth and position. Despite limitations in sample size and population specificity, the findings underscore the importance of detailed anatomical knowledge for safer and more effective injectable procedures. Ultrasound imaging serves as a healthcare tool in guiding aesthetic interventions in the temporal region.

Keywords: *Temporal Region Anatomy, Deep Temporal Arteries, High-Frequency Ultrasound, Clinical Safety, Thai Population*

INTRODUCTION

Aging is a dynamic and continuous process influenced by genetic and environmental factors such as sun exposure, wind, and trauma. Additionally, smoking and estrogen loss can accelerate aging, leading to morphological and physiological changes in the skin, subcutaneous fat, fasciae, muscles, ligaments, and bones (Hussein et al., 2025; Wong & Chew, 2021). These changes contribute to facial aging, prompting increased demand for esthetic interventions, including both surgical and non-surgical techniques (Farage et al., 2007; Meyer & Quarta, 2023; Zhang et al., 2024).

The temporal region, located between the forehead and the ear, plays a crucial role in both function and appearance. This area consists of multiple anatomical layers, including the subperiosteum, temporalis muscle, deep and superficial temporal fascia, subgaleal fascia, subcutaneous tissue, and skin (Bohr et al., 2025; Velthuis et al., 2021). Interventions in this region require precise anatomical knowledge to ensure safety due to its complex layered structure and intricate vascular pathways (Hong et al., 2025; Cotofana et al., 2022). Previous studies have indicated that the supraperiosteal layer of the temporal fossa is a relatively safe site for deep temple augmentation because major blood vessels, such as the superficial temporal artery and middle

Corresponding author's email: sirintip.mfu@gmail.com

temporal vein, run superficially to this plane (Beleznay et al., 2015; Bae et al., 2023). However, the deep temporal arteries, branches of the maxillary artery, traverse the temporal fossa and may anastomose with adjacent arteries, including the lacrimal, supraorbital, and middle meningeal arteries (Amans et al., 2023). Understanding the precise depth and position of these arteries is essential for preventing complications during injectable procedures (Accioli et al., 2003; Bénateau et al., 2002; Collier, 2015; Lee et al., 2023; Sihag et al., 2020).

High-frequency ultrasound has emerged as a valuable tool for real-time visualization of anatomical structures, offering a noninvasive, cost-effective, and precise method for assessing the depth and position of arteries and soft tissues in the temporal region (Alimova et al., 2023; Gyöngy et al., 2024; Haykal et al., 2023; Li et al., 2023; Sigrist et al., 2024). There is a broad consensus regarding its clinical and anatomical utility across recent literature. For instance, Zhao et al. (2023) demonstrated the effectiveness of ultrasound in analyzing layered anatomy in the Chinese population, highlighting the advantages of ultrasound over cadaver-based methods. Lee et al. (2022a) confirmed ultrasound's role in enhancing the safety of hyaluronic acid filler procedures by guiding injections and identifying vascular pathways. Similarly, Bae et al. (2023) emphasized the importance of mapping the deep temporal arteries during augmentation procedures to avoid vascular complications.

Although these studies agree on the clinical value of ultrasound, they diverge in scope and population focus. Zhao et al. (2023) emphasized anatomical description in a Chinese cohort; Lee et al. (2022a) focused on procedural technique and complication prevention; and Bae et al. (2023) focused on vascular depth and mapping. Notably, these studies were all conducted outside the Thai context and did not examine potential changes in anatomical structures due to prior filler injections. This represents a clear gap in ethnic-specific anatomical data and the impact of past interventions on soft tissue and vascular positioning. This study addresses this dual gap by integrating anatomical assessment and procedural safety considerations within a Thai population, thereby contributing to both clinical practice and population-specific anatomical knowledge.

Although these studies provide valuable insights, limited research has focused specifically on the depth and position of the deep temporal artery and soft tissues in the Thai population. Given that facial anatomical characteristics, including soft tissue thickness and vascular structure, can vary by ethnicity and geographic population, generating Thai-specific data is important to ensure the safety and efficacy of esthetic procedures in this demographic (Farkas et al., 2005). Studies conducted in other populations, such as Chinese or White groups, may not fully capture the anatomical nuances of Thai individuals (Zhao et al., 2023). This constitutes a practical gap in the literature, as anatomical variations between ethnic groups may influence the safety and effectiveness of aesthetic procedures (Bae et al., 2023; Ma et al., 2024; Nikolis et al., 2024).

This study is grounded in anatomical and diagnostic frameworks commonly used in aesthetic and reconstructive medicine. It builds on established anatomical models describing the layered structure of the temporal region, comprising the skin, subcutaneous tissue, SMAS, temporalis muscle, and deep temporal arteries, as documented in cadaveric studies (Moss et al., 2000; Velthuis et al., 2021) and more recently validated through high-resolution ultrasound (Lee et al., 2022a; Zhao et al., 2023). The study also adopted ultrasound diagnostic standards that enable non-invasive, real-time assessment of these structures, aligning with current clinical practices in esthetic safety protocols (Haykal et al., 2023; Bae et al., 2023). By integrating these anatomical and imaging benchmarks, this study aims to contribute to both academic anatomical understanding and clinical safety improvements in the Thai population.

Given the increasing demand for filler injections in Thailand and the associated risk of vascular complications, it is critical to understand population-specific anatomy (Chakhachiro & Waseem 2025; Jitaree et al., 2021; Phumyoo et al., 2014; Tansatit et al., 2017). Esthetic procedures involving the temporal region are increasing in popularity among Thai patients (International Trade Administration, 2024); however, complications such as vascular occlusion persist due to insufficient population-specific anatomical data. This applied research seeks to address this clinical gap by providing detailed sonographic mapping of Thai individuals' temporal anatomy. Therefore, this study addresses an applied research aim: to provide practical, population-specific data using HFUS to guide safer and more effective clinical interventions. Specifically, this study aimed to (1) determine the depth and position of the deep temporal arteries using high-frequency ultrasound in Thai adults aged 25–50 years, (2) compare the structural characteristics of the temporal soft tissue layers between individuals with and without a history of filler injection, and (3) provide clinical recommendations that improve the safety and precision of injectable procedures in the temporal region for Thai patients.

This study provides both practical and theoretical contributions. On a practical level, the findings offer critical insight for clinicians seeking to reduce risks in temporal filler procedures, particularly in the Thai population. The detailed ultrasound-based mapping of vascular and soft tissue structures supports safer injection techniques and can inform population-specific clinical guidelines and training protocols. Theoretically, this study enhances anatomical knowledge by identifying structural differences in the temporal region associated with prior filler use and ethnic variability. These findings serve as a foundation for further anatomical, biomedical, and esthetic intervention studies in Asian populations.

Based on the existing literature, this study advances three hypotheses. First, individuals with a history of HA filler injections are expected to show significant differences in the thickness of temporal soft tissue layers, specifically, the skin, subcutaneous fat, SMAS, temporalis muscle, and temporal bone, compared with those without a history of filler injections. This assumption aligns with Funt and Pavicic's (2015) findings, who suggested long-term structural alterations following filler use. Second, it is hypothesized that the depth and positioning of the deep temporal artery differ between groups, as prior interventions may displace vascular structures. Third, the artery is anticipated to more frequently appear above the periosteum in the filler group, a pattern previously noted in studies assessing post-intervention vascular pathways. These hypotheses are grounded in anatomical and imaging literature (Zhao et al., 2023; Lee et al., 2022a) and aim to address critical gaps in population-specific anatomy and esthetic procedure safety in the Thai context.

RESEARCH METHOD

Samples and Sample Size Determination

This study employed a quantitative descriptive design with a cross-sectional approach to assess the anatomical characteristics of the temporal region in Thai adults. The study was conducted at Mae Fah Luang Hospital in Bangkok and included healthy Thai males and females aged 25–50 years, both with and without prior filler injections in the temporal facial region. A purposive sampling strategy was used to recruit participants who met the inclusion and exclusion criteria. The sample size (n = 33) was guided by Zhao et al. (2023), who conducted a similar ultrasound-based anatomical study in an Asian population. No formal power analysis was performed due to the exploratory nature of this research; however, the sample was considered sufficient to identify structural differences between groups. A 10% dropout allowance was also included to ensure adequate representation.

The study adhered to Good Clinical Practice (GCP) guidelines and was approved by the Mae Fah Luang Ethics Committee on Human Research (Approval No. EC 24008-20). Eligible participants provided informed consent, acknowledging the study's purpose, risks, and potential publication of images. The exclusion criteria were pregnancy, lactation, psychiatric disorders, autoimmune diseases, HIV, allergies to ultrasound gel, facial vascular malformations, and a history of fat grafting, thread lifting, or facial surgery. Participants could withdraw at any time, particularly in cases of adverse reactions to the ultrasound gel, such as itching or burning. Researchers also reserve the right to terminate participation in cases of severe allergic reactions.

Study Procedure and Ultrasound Scanning

Eligible volunteers provided informed consent before enrollment. Data collection involved high-frequency ultrasound scanning (VENUE, GE Healthcare, USA) using a hockey-stick probe (2.5–16.8 MHz). Before scanning, the faces of the participants were cleansed, and ultrasound gel was applied to the temporal regions.

Ultrasound was performed perpendicularly (T1, T2) and parallel (T1, T3) to the temporal crest to assess the periosteum, deep temporal artery, and soft tissue layers (Figure 1a, 1b). Each session lasted for 10–15 minutes, after which the gel was removed and the face was rinsed.

The temporal soft tissue layers were analyzed, and measurements were taken for both the left (LT) and right (RT) regions under two conditions: with and without filler injection. Depth variables included D1 (skin thickness), D2 (subcutaneous layer), D3 (SMAS layer), D4 (temporal bone), and D5 (temporalis muscle) (Figure 2).

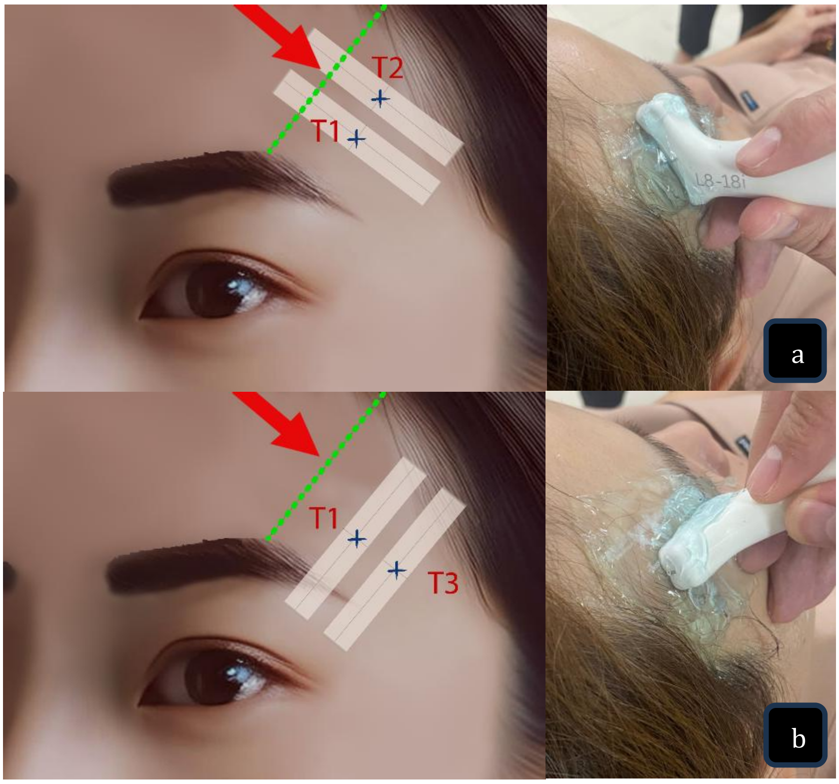

Figure 1. Probe positioning and measurement layers: (a) Perpendicular scanning at points T1 and T2 and (b) Parallel scanning at points T1 and T3 along the temporal crest
Source: Adobe Systems (2021)

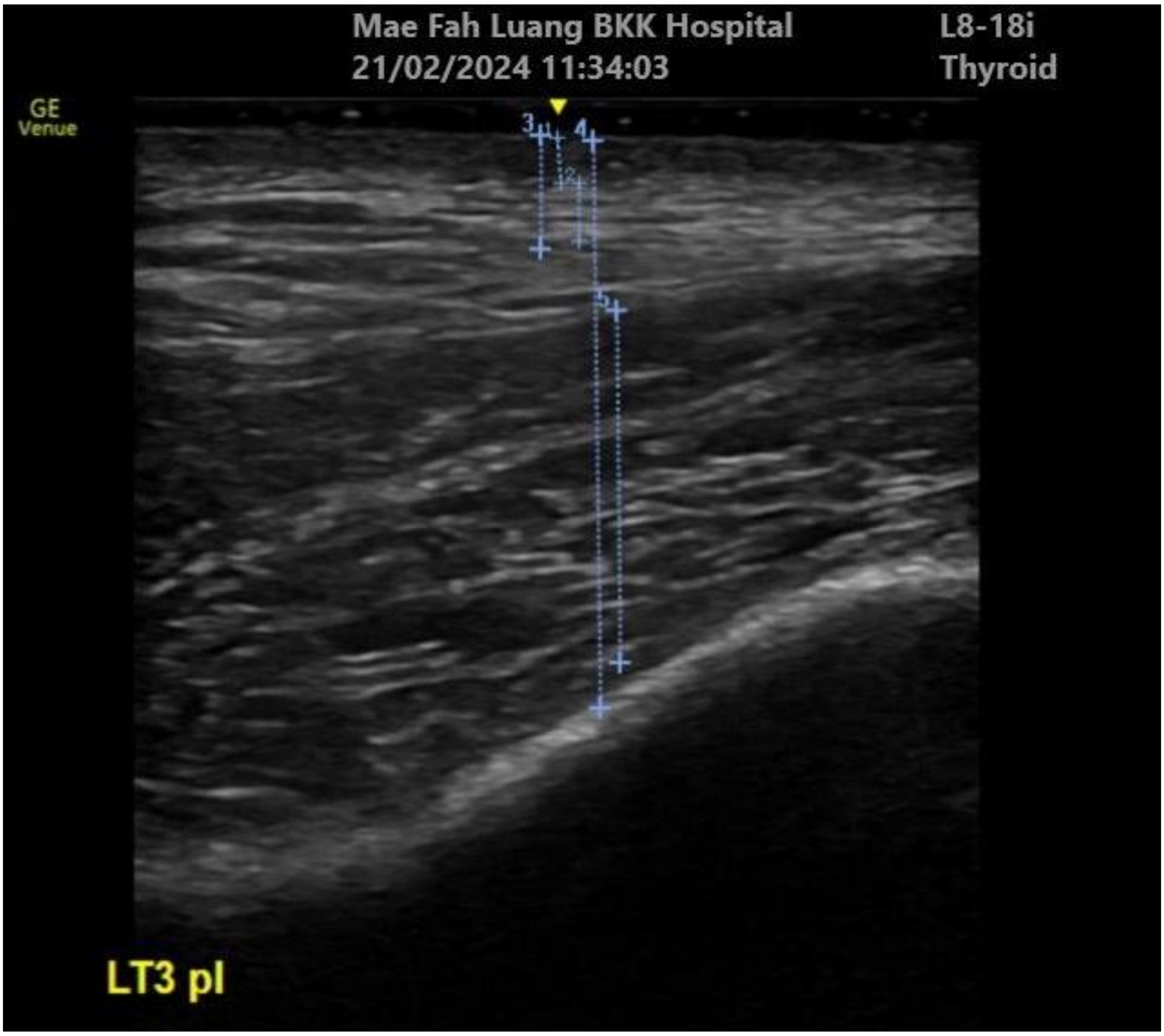

Figure 2. Temporal soft tissue layers for ultrasound assessment, with depth measurements: 1 = D1, 2 = D2, 3 = D3, 4 = D4, and 5 = D5.

All ultrasound assessments were performed under a single experienced radiologist with extensive expertise in musculoskeletal and facial ultrasound. To evaluate intra-observer reliability, a subset of 10 participants (30%) was re-measured after a 1-week interval under identical imaging conditions. Additionally, standardized protocols for probe positioning and anatomical landmark identification were followed to enhance the measurement validity.

Data collection and analysis

All data were recorded in the case record form, including demographic information such as gender, age, marital status, underlying diseases, allergy history, and history of temporal procedures. Ultrasound imaging was performed using the Venue (GE Healthcare, USA) machine to measure the depth and position of deep temporal arteries and soft tissues in centimeters. Additionally, images of both temporal regions were captured for data analysis, and each region was manually mapped by the investigator. Descriptive statistics were used to summarize general demographic data, including gender, underlying diseases, allergy history, and history of temporal procedures. Quantitative data, such as age and the depth and position of temporal arteries and soft tissues, were analyzed and presented as means, standard deviations, maximum values, and minimum values.

Furthermore, the distribution of outcomes was examined based on age and history of filler and non-filler injections.

Descriptive statistics, including means, standard deviations, and frequency distributions, were used to summarize and present the anatomical measurements across the study groups. This approach was appropriate given the descriptive and exploratory nature of the study, which aimed to characterize the anatomical features of the temporal region in a specific population without testing hypotheses for group differences. The use of descriptive statistics allowed for the clear presentation of structural patterns and variations, which is consistent with similar anatomical studies that focus on observational data rather than inferential comparisons. Mann-Whitney U test was performed (see **Table 5**).

Quantitative data on temporal region soft tissue thickness (D1–D5), artery depth (D6), and artery position (D7) were analyzed. Data analysis was performed using RStudio (v2024.12.1+563, "Kousa Dogwood") and Quarto (v1.5.57) (RStudio, PBC; https://www.r-project.org/). Data were imported from Excel and grouped based on the history of filler injection (Filler vs. Non-Filler). For each anatomical position (T1PP, T2PP, T1PL, T3PL), Mann–Whitney U test was conducted to compare the mean values of D1–D6 between the groups. Descriptive frequencies for artery position (D7) were tabulated, and exploratory trends were identified. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

General Characteristics of the Participants

This study included 33 participants (66 temporal regions) who visited Mae Fah Luang University Hospital in Bangkok over 1 month (March–April). Table 1 summarizes the demographic characteristics, including gender distribution, age, and history of filler injections.

Among the participants, 15.15% were male (n = 5) and the majority, 84.85% (n = 28), were female. The mean age of all participants was 33.42 ± 6.38 years (range, 25–46 years). Participants were further categorized into two age groups: 45.45% (n = 15) were between 25 and 30 years old and 54.55% (n = 18) were older than 30 years.

Regarding filler history, 30.30% (n = 10) of the participants had previously undergone filler injections, with an average filler duration of 32.4 ± 24.53 months (ranging from 6 to 72 months). The remaining 69.70% (n = 23) had no history of filler injections. Among those who had received fillers, the gender distribution was as follows: 80.00% female and 20.00% male. In the non-filler group, 86.96% were female and 13.04% were male. The mean age was similar between the two groups, with those in the filler group averaging 34.00 ± 6.15 years and those in the non-filler group averaging 34.17 ± 6.49 years.

These findings indicate that most participants were female and that a substantial proportion had no prior filler exposure. The results also suggest that individuals who had received fillers maintained them for various durations, emphasizing the variability in filler use. A more detailed breakdown of these characteristics is presented in Table 1.

Table 1. Demographic characteristics of the study participants (n = 33), including age, sex, and history of esthetic procedures.

Characteristics	History of the filler		Total
	Yes (n = 10)	No (n = 23)	(n = 33)
Gender, n (%)			
Male	2 (20.00)	3 (13.04)	5 (15.15)

Characteristics	History of the filler		Total
	Yes (n = 10)	No (n = 23)	(n = 33)
Female	8 (80.00)	20 (86.96)	28 (84.85)
Age (years), Mean±SD (min - max)	34 ± 6.15 (25 - 43)	34.17 ± 6.49 (25 - 46)	33.42 ± 6.38 (25-46)
25–30 years old, n (%)	4 (40.00)	11 (47.83)	15 (45.45)
> 30 years old, n (%)	6 (60.00)	12 (52.17)	18 (54.55)
Duration (months) of filler injection Mean ± SD (Min-Max)	32.4± 24.53 (6 - 72)	N/A	-

Comparison of Soft Tissue Thickness in the Filler and Non-Filler Injection Groups

Tables 2a and 2b present the soft tissue thickness measurements at various depths for the left temporal (LT) and right temporal (RT) regions under filler and non-filler conditions. The measurements were categorized into five depth variables: D1 (skin thickness from surface to fat), D2 (subcutaneous layer from subdermal to SMAS), D3 (SMAS from skin surface to SMAS layer), D4 (temporal bone from skin surface to bone), and D5 (temporalis muscle thickness). Across all positions, filler injections resulted in slightly lower D4 values in most cases compared with the non-filler group, suggesting minor alterations in soft tissue structure. However, the overall thickness patterns remained similar between LT and RT, with slight variations in specific layers, such as the temporal bone (D4) and temporalis muscle (D5).

Table 2a. Mean soft tissue thickness (in mm) in the temporal region of the filler injection group *(n=10)*, measured via high-frequency ultrasound.

Area	Left Temporal (LT)			Right Temporal (RT)		
	Min	**Max**	**Mean±SD**	**Min**	**Max**	**Mean±SD**
Temporal 1 Perpendicular (T1PP)						
D1	0.12	0.16	0.13±0.01	0.12	0.16	0.13±0.01
D2	0.12	0.16	0.14±0.01	0.12	0.16	0.14±0.01
D3	0.26	0.36	0.30±0.03	0.26	0.37	0.31±0.04
D4	0.85	1.28	1.07±0.16	0.80	1.65	1.20±0.27
D5	0.38	0.66	0.52±0.10	0.34	0.78	0.55±0.12
Temporal 2 Perpendicular (T2PP)						
D1	0.12	0.16	0.13±0.01	0.12	0.16	0.13±0.01
D2	0.10	0.17	0.13±0.02	0.12	0.17	0.14±0.02
D3	0.24	0.40	0.30±0.04	0.26	0.40	0.31±0.04
D4	0.56	1.14	0.90±0.20	0.56	1.26	0.92±0.23
D5	0.22	0.60	0.44±0.15	0.22	0.71	0.43±0.13
Temporal 1 Parallel (T1PL)						
D1	0.12	0.16	0.13±0.02	0.12	0.16	0.13±0.01
D2	0.11	0.16	0.14±0.02	0.11	0.17	0.14±0.02
D3	0.24	0.32	0.29±0.03	0.26	0.40	0.30±0.05
D4	0.74	1.97	1.07±0.38	0.81	1.81	1.19±0.28
D5	0.25	1.12	0.51±0.26	0.28	0.77	0.55±0.15

Area	Left Temporal (LT)			Right Temporal (RT)		
	Min	Max	Mean±SD	Min	Max	Mean±SD
Temporal 3 Parallel (T3PL)						
D1	0.12	0.16	0.13±0.01	0.12	0.16	0.13±0.01
D2	0.10	0.17	0.14±0.02	0.10	0.17	0.14±0.01
D3	0.26	0.36	0.32±0.03	0.26	0.40	0.33±0.05
D4	0.99	1.88	1.51±0.28	0.14	2.19	1.40±0.57
D5	0.48	1.09	0.72±0.21	0.36	1.09	0.75±0.26

Note:** ***D1: *Skin thickness: from the skin surface to fat*; ***D2***: *Subcutaneous layer: from the subdermal layer to the SMAS layer;* ***D3***: *SMAS: from the skin surface to the SMAS layer;* ***D4***: *Temporal bone: from the skin surface to bone;* ***D5***: *Temporalis muscle thickness. The unit of thickness is centimeters.*

Table 2b. Mean soft tissue thickness (in mm) in the temporal region of the non-filler injection group *(n=23)*, measured via high-frequency ultrasound.

Area	Left Temporal (LT)			Right Temporal (RT)		
	Min	Max	Mean±SD	Min	Max	Mean±SD
Temporal 1 Perpendicular (T1PP)						
D1	0.12	0.16	0.13±0.01	0.12	0.16	0.14±0.01
D2	0.10	0.18	0.14±0.02	0.10	0.18	0.14±0.02
D3	0.26	0.39	0.31±0.04	0.26	0.37	0.31±0.03
D4	0.63	1.82	1.17±0.28	0.75	2.05	1.23±0.32
D5	0.34	0.94	0.56±0.15	0.24	0.98	0.55±0.18
Temporal 2 Perpendicular (T2PP)						
D1	0.12	0.16	0.13±0.01	0.12	0.16	0.14±0.01
D2	0.10	0.19	0.13±0.02	0.10	0.17	0.14±0.02
D3	0.24	0.43	0.30±0.04	0.26	0.38	0.31±0.04
D4	0.54	1.42	0.90±0.22	0.49	1.73	0.93±0.31
D5	0.17	0.85	0.41±0.15	0.17	0.78	0.42±0.17
Temporal 1 Parallel (T1PL)						
D1	0.12	0.16	0.13±0.01	0.12	0.16	0.14±0.01
D2	0.10	0.17	0.14±0.02	0.10	0.18	0.14±0.02
D3	0.26	0.38	0.31±0.04	0.26	0.39	0.32±0.04
D4	0.58	1.70	1.07±0.27	0.73	1.64	1.20±0.25
D5	0.20	0.80	0.47±0.16	0.29	0.87	0.54±0.17
Temporal 3 Parallel (T3PL)						
D1	0.12	0.16	0.14±0.01	0.12	0.16	0.14±0.01
D2	0.10	0.18	0.14±0.02	0.10	0.17	0.14±0.02
D3	0.26	0.43	0.32±0.04	0.24	0.43	0.32±0.05
D4	1.00	1.99	1.47±0.26	0.78	2.18	1.49±0.30
D5	0.42	1.07	0.66±0.16	0.37	0.95	0.68±0.14

Note:** ***D1: *Skin thickness: from the skin surface to fat*; ***D2***: *Subcutaneous layer: from the subdermal layer to the SMAS layer;* ***D3***: *SMAS: from the skin surface to the SMAS layer;* ***D4***: *Temporal bone: from the skin surface to bone;* ***D5***: *Temporalis muscle thickness. The unit of thickness is centimeters.*

Depth and Position of the Deep Temporal Artery

Table 3 and Figure 3 present the measurements of the deep temporal artery (D6) at four positions: Temporal 1 Perpendicular (T1PP), Temporal 2 Perpendicular (T2PP), Temporal 1 Parallel (T1PL), and Temporal 3 Parallel (T3PL). Measurements are provided for both left temporal

(LT) and right temporal (RT) regions, comparing conditions with and without filler injections. Overall, the results indicate considerable variability in the deep temporal artery depth across different measurement points (T1PP, T2PP, T1PL, and T3PL) and between conditions with and without filler injection. In the filler injection group, the left temporal (LT) region generally exhibited higher mean distances compared to the right temporal (RT) region, with notable variability. Specifically, T2PP in the LT region had the highest mean depth (1.13 ± 0.90 cm), whereas T1PL in the RT region had the lowest mean depth (0.44 ± 0.48 cm). In the non-filler group, the measurements showed more balanced depth values between LT and RT, with T2PP in the RT region having the highest mean depth (1.06 ± 0.86 cm). Across all conditions, depth variability was evident, suggesting individual anatomical differences and potential effects of filler injections on arterial positioning.

Table 3. Depth and position of the deep temporal artery in the temporal fossa among Thai adults (*n = 33*), stratified by injection plane.

Position	Left Temporal (LT)			Right Temporal (RT)		
	Min	Max	Mean±SD	Min	Max	Mean±SD
Filler injection (n=10)						
T1PP	0	2.07	1.07±0.85	0.00	1.38	0.42±0.53
T2PP	0.00	2.32	1.13±0.90	0	2.06	0.66±0.89
T1PL	0.00	2.09	0.65±0.60	0.00	1.50	0.44±0.48
T3PL	0.00	2.35	0.78±0.88	0.00	2.11	0.62±0.84
Non-filler injection (n=23)						
T1PP	0.00	2.23	0.97±0.77	0.00	2.20	0.92±0.89
T2PP	0.00	2.34	0.71±0.89	0.00	2.36	1.06±0.86
T1PL	0.00	2.42	0.74±0.81	0.00	2.28	0.69±0.72
T3PL	0.00	2.35	0.65±0.84	0.00	2.24	0.67±0.80

*Note: D6: Deep Temporal artery; measure the distance from the temporal crest to the artery (in centimeter).

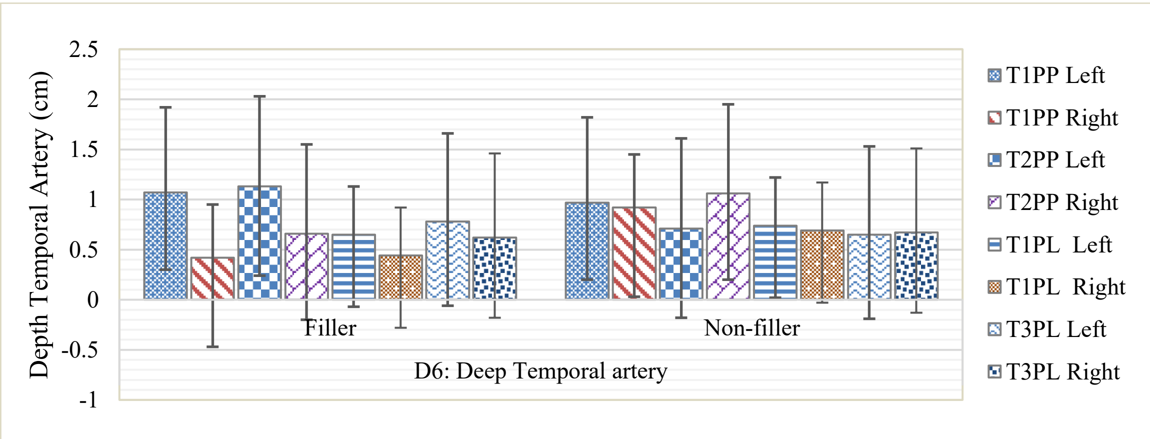

Figure 3. Display bar graph and error bar showing the depth of the right and left Temporal artery at the T1PP, T2PP, T1PL, and T3PL, including a history of filler injection.

Position of the Deep Temporal Artery

Table 4 summarizes the position of the deep temporal artery at different measurement points (T1PP, T2PP, T1PL, and T3PL) on both the left (LT) and right (RT) temporal sides, comparing filler and non-filler injection cases. The ultrasound images are shown in Figure 4.

Temporal Perpendicular Positions (T1PP & T2PP)

The artery was most commonly located above the periosteum in the filler injection group, with frequencies ranging from 30% to 60% across sites. The highest occurrence of an absent artery was observed at T3PL (50% on the LT and 40% on the RT). In contrast, placement beneath the temporal muscle's deep surface was least frequent, particularly at T3PL (0% LT, 20% RT).

A similar trend was observed for the non-filler injection group, with the most common position above the periosteum, except at T2PP (43.48% LT, 30.43% RT) and T3PL (39.13% LT, 21.74% RT), where absent arteries were also frequently noted. The absence of the artery was highest at T3PL (52.17% LT, 60.87% RT), whereas positioning beneath the temporal muscle was more common at T1PP (21.74% LT, 34.78% RT) and T2PP (13.04% LT, 34.78% RT).

Temporal Parallel Positions (T1PL & T3PL)

In the filler injection group, the artery was predominantly above the periosteum at both T1PL (50% LT, 50% RT) and T3PL (50% LT, 40% RT). Absent arteries were observed in 20%–50% of cases, with the highest frequency at T3PL (50% LT, 40% RT).

In the non-filler injection group, the above-periosteum position remained the most frequent at T1PL (60.87% LT, 43.48% RT), but at T3PL, the absent artery was the most common (52.17% LT, 60.87% RT). The beneath-muscle position was the least frequent across all sites, occurring in 8.70%–21.74% of cases.

Overall, the results indicate that the artery is most often located above the periosteum but varies based on the site and history of injection. The absence of the artery is more frequent in non-filler cases, particularly at the T3PL.

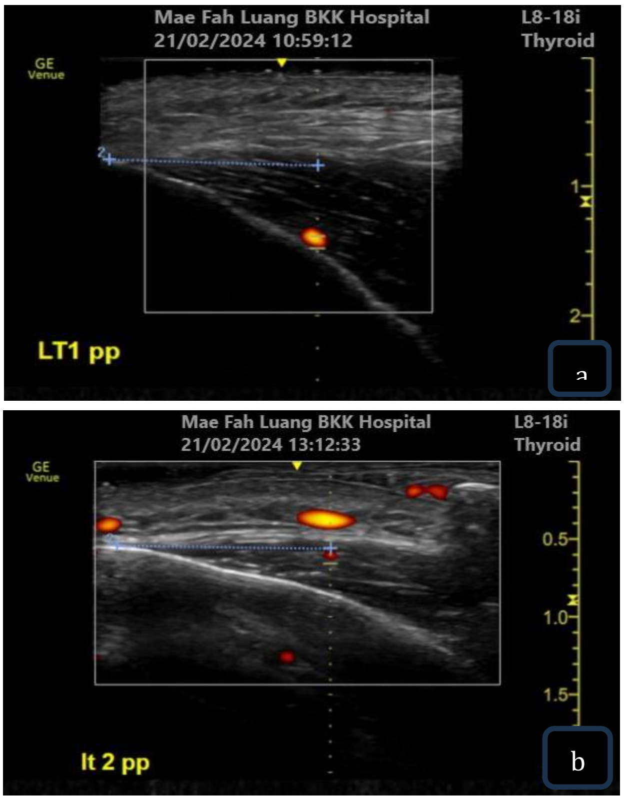

Figure 4. Ultrasound detected the deep temporal artery: (a) above the periosteum and (b) beneath the temporal muscle's deep surface

Table 4. Comparison of anatomical layer thickness in the temple area between participants with and without a history of filler injection.

Side/Position/Group	Left Temporal (LT)				Right Temporal (RT)			
	T1PP	**T2PP**	**T1PL**	**T3PL**	**T1PP**	**T2PP**	**T1PL**	**T3PL**
Filler injection (n=10)								
- Beneath the deep surface of the temporal muscle's deep surface n(%)	2(20)	1(10)	3(30)	0	1(10)	2(20)	3(30)	2(20)
- Above the periosteum n(%)	6(60)	6(60)	5(50)	5(50)	4(40)	3(30)	5(50)	4(40)
- Absent artery n(%)	2(20)	3(30)	2(20)	5(50)	5(50)	5(50)	2(20)	4(40)
Non-filler injection (n=23)								
- Beneath the temporal muscle's deep surface n(%)	5(21.74)	3(13.04)	3(13.04)	2(8.70)	8(34.78)	8(34.78)	5(21.74)	4(17.39)
- Above the periosteum n(%)	12(52.17)	10(43.48)	14(60.87)	9(39.13)	8(34.78)	7(30.43)	10(43.48)	5(21.74)
- Absent artery n(%)	6(29.09)	10(43.48)	16(69.56)	12(52.17)	7(30.43)	9(39.13)	8(34.78)	14(60.87)

Impact of Filler on Tissue Thickness

As shown in **Table 5**, Independent t-tests comparing tissue thickness measurements (D1–D5) between the Filler and Non-Filler groups at four anatomical positions (T1PP, T2PP, T1PL, T3PL) revealed no statistically significant differences (p > 0.05) for all variables. However, the subcutaneous tissue thickness (D2) at position T1PL showed a trend toward increased thickness in the filler group (mean = 0.143 cm) compared to the non-filler group (mean = 0.135 cm), approaching significance (p = 0.075). These results suggest that filler injection does not significantly alter most soft tissue thickness parameters in the temporal region, although localized changes in subcutaneous tissue may occur.

Table 5. Comparison of tissue in the temporal region thickness (D1–D5) between the filler and non-filler groups across the anatomical positions

Position	Variable	Filler Mean (cm)	Non-Filler Mean (cm)	p-value
T1PP	D1	0.135	0.135	0.891
	D2	0.140	0.138	0.750
	D3	0.310	0.306	0.757
	D4	1.115	1.211	0.123
	D5	0.537	0.555	0.576
T2PP	D1	0.134	0.134	0.923
	D2	0.139	0.134	0.399
	D3	0.303	0.301	0.798
	D4	0.893	0.935	0.488
	D5	0.424	0.428	0.915
T1PL	D1	0.134	0.135	0.889
	D2	0.143	0.135	**0.075**
	D3	0.311	0.304	0.472
	D4	1.174	1.148	0.755
	D5	0.585	0.518	0.175
T3PL	D1	0.134	0.136	0.630

Note:** ***D1: *Skin thickness: from the skin surface to fat*; ***D2***: *Subcutaneous layer: from the subdermal layer to the SMAS layer;* ***D3***: *SMAS: from the skin surface to the SMAS layer;* ***D4***: *Temporal bone: from the skin surface to bone;* ***D5***: *Temporalis muscle thickness. The unit of thickness is centimeters.*

Discussion

The temporal region is highly vulnerable and plays a significant role in facial esthetics. Temporal hollowing can make individuals appear tired, aged, and less approachable. Although it can affect people of all ages, it tends to worsen with aging, making corrective interventions essential. The temporal area resembles a scallop when viewed laterally, with the zygomatic arch at the base, the lateral orbital bone and auricle forming the sides, and the fan-shaped temporal crest. Due to its unique spatial structure, depression typically occurs in the medial portion of the waist, within the area bounded by points T1 to T2 and T3. The temporal bone forms a pronounced convexity where it significantly protrudes near the lateral orbital rim. The depression is shallower at the rear and deepest at the medial waist. Additionally, the zygomatic arch and temporal bone are separated by a wide space, and the unsupported masseter muscle beneath allows the fat pad to easily descend, contributing to the region's hollowing.

However, filler injections in this region carry significant risks due to the complexity of the temporal anatomy. Understanding the distribution and depth of soft tissues over time is crucial for safe and effective treatment. Although cadaver studies have provided valuable insights into tissue composition (Moss et al., 2000), they cannot precisely determine tissue depth. In this regard, high-frequency ultrasound is a valuable tool, allowing for accurate assessment of the thickness of the temporal anatomical structures, including the skin, subcutaneous layer, SMAS, temporalis muscle, and temporal bone. This knowledge enables precise spatial localization during surgical and non-surgical interventions, thereby improving safety and outcomes.

The current study highlights significant structural variations in the filler and non-filler groups, particularly in the deeper tissues. The observed differences align with Funt and Pavicic (2015), who found that filler injections alter the characteristics of deeper tissues, likely due to fibrosis or edema. Ultrasound detection at T1PP revealed thinner soft tissue in filler-injected subjects, which may be due to prolonged filler retention (up to 72 months).

Lamb and Surek (2018) identified T1 as a safe injection zone located 1 cm above the supraorbital rim along the temporal fusion line. However, using ultrasonography, our findings indicate the deep temporal artery at this site, contradicting prior assumptions and emphasizing the need for individualized assessment. This aligns with de Sanctis et al. (2021) and Zaree et al. (2023), who advocated for customized injection strategies based on detailed anatomical mapping.

The observed variability in tissue thickness and arterial positioning underscores the importance of meticulous pre-procedural planning. Using ultrasound for individualized anatomical mapping can significantly enhance both safety and esthetic outcomes in TF procedures.

Limitations and Future Research Directions

This study is limited by its relatively small sample size and cross-sectional design, which may restrict the generalizability of the findings to broader populations. In addition, all measurements were performed by a single operator, and intra-observer reliability was not formally tested. Future studies should consider employing larger, multicenter cohorts and including diverse ethnic groups to assess anatomical variability across populations. Further research could use longitudinal designs to observe anatomical changes over time, particularly in relation to repeated filler use. Moreover, integrating other imaging modalities, such as magnetic resonance imaging (MRI) or 3D ultrasound, could enhance the anatomical resolution and validation of vascular structures in relation to aesthetic landmarks. These directions will help refine clinical protocols and deepen the theoretical understanding of soft tissue dynamics in esthetic procedures.

CONCLUSION

This study offers both theoretical and practical contributions to facial anatomy and aesthetic clinical practice. Our findings support the integration of ultrasound imaging into routine aesthetic procedures, particularly for temporal filler injections, to improve patient safety and injection precision. Clinicians are encouraged to use real-time ultrasound to identify vascular structures and tissue depth, especially in patients with a history of filler treatments. From a policy and training perspective, these findings suggest the need to update educational curricula and clinical training protocols to include ultrasound-based anatomical assessment techniques. Theoretically, the study contributes to health care knowledge by refining anatomical understanding of the temporal region in the Thai population, revealing potential population-specific variations in soft tissue thickness and artery location. These variations may challenge assumptions based on Western anatomical models and should inform localized clinical guidelines and future research frameworks. This study reinforces the need for healthcare regarding ultrasound guidance in aesthetic procedures, particularly for Thai patients, to mitigate the risks associated with vascular anatomy variability.

ACKNOWLEDGMENT

We sincerely thank the dedicated staff of Mae Fah Luang University for their invaluable support. Our deepest gratitude also goes to the volunteers and participants, whose contributions made this study possible.

AUTHOR CONTRIBUTIONS

Conceptualization: CL, SC, CK, and TS; Methodology: CL, SC, CK, and TS; Validation: CL, SC, CK, and TN; Formal analysis and investigation: CL, SC, CK, and TS; Writing - Original Draft: CL, SC, and TS; Writing - Review & Editing: SR, SC, and TS; Visualization: SR, SC, and TS; Supervision: SC and TN; Project administration: SC.

CONFLICT OF INTEREST

The authors have no competing interests to declare relevant to this article's content.

REFERENCES

Accioli de Vasconcellos, J. J., Britto, J. A., Henin, D., & Vacher, C. (2003). The fascial planes of the forehead and temple: An en-bloc anatomical study and a plea for consistency. *British Journal of Plastic Surgery, 56*(7), 623–628. https://doi.org/10.1016/S0007-1226(03)00310-2

Adobe Systems. (2021). *Adobe Photoshop version 22.5.1 system information report*. Adobe Inc. Retrieved from the internal system report.

Alimova, S., Sharobaro, V., Yukhno, A., & Bondarenko, E. (2023). Possibilities of ultrasound examination in the assessment of age-related changes in the soft tissues of the face and neck: A review. *Applied Sciences, 13*(2), 1128. https://doi.org/10.3390/app13021128

Amans, M. C., Cotofana, S., Cucchiara, V. P., & Kau, A. M. (2023). Anatomical mapping of the deep temporal arteries and maxillary arterial branches: Implications for facial and cranial vascular networks. *Clinical Anatomy, 36*(5), 589–599. https://doi.org/10.1002/ca.23952

Bae, H., Choi, Y. J., Lee, K. L., Gil, Y. C., Hu, K. S., & Kim, H. J. (2023). The deep temporal arteries: Anatomical study with application to augmentation procedures of the temple. *Clinical Anatomy, 36*(3), 386–392. https://doi.org/10.1002/ca.23952

Beleznay, K., Carruthers, J. D., Humphrey, S., & Jones, D. (2015). Avoiding and treating blindness from fillers: A review of the world literature. *Dermatologic Surgery, 41*(10), 1097–1117. https://doi.org/10.1097/DSS.0000000000000486

Bénateau, H., Labbé, D., Rigot-Jolivet, M., Elissalde, J. M., & Salamé, E. (2002). The temporal periosteum: Anatomical study and surgical implications. *Annales de Chirurgie Plastique Esthétique, 47*(3), 189–195. https://doi.org/10.1016/S0294-1260(02)00110-3

Bohr, C., Bajaj, J., Soriano, R. M., et al. (2025). Anatomy, head and neck, temporoparietal fascia. [Updated 2023 Jul 24]. In *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing. Available from https://www.ncbi.nlm.nih.gov/books/NBK507912/?utm_source=chatgpt.com

Chakhachiro, A., & Waseem, M. (2025, April). Risk factor analysis for vascular occlusions after dermal filler injections: A systematic review and meta-analysis. *Cureus, 17*(4), e82800. https://doi.org/10.7759/cureus.82800

Collier, H. (2015). Temple restoration. *Plastic, Maxillofacial Surgery and Aesthetics Journal, 3*(1). https://www.thepmfajournal.com/features/features/post/temple-restoration

Cotofana, S., Gotkin, R. H., & Lachman, N. (2022). Vascular safe zones for facial soft-tissue filler injections: Clinical anatomy and danger zones. *Plastic and Aesthetic Nursing, 42*(2), 84–89.

de Sanctis Pecora, C., Pinheiro, M. V. B., Ventura Ferreira, K., Jacobino de Barros Nunes, G., & Miot, H. A. (2021). The One21 technique: An individualized treatment for glabellar lines based on clinical and anatomical landmarks. *Clinical, Cosmetic and Investigational Dermatology*, 14, 97–105. https://doi.org/10.2147/CCID.S281901

Farage, M. A., Miller, K. W., Elsner, P., & Maibach, H. I. (2007). Intrinsic and extrinsic factors in skin ageing: A review. *International Journal of Cosmetic Science, 29*(2), 87–95.

Farkas, L. G., Katic, M. J., & Forrest, C. R. (2005). International anthropometric study of facial morphology in various ethnic groups/races. *Journal of Craniofacial Surgery, 16*(4). Retrieved from https://journals.lww.com/jcraniofacialsurgery/fulltext/2005/07000/international_anthropometric_study_of_facial.16.aspx

Funt, D., & Pavicic, T. (2015). Dermal fillers in aesthetics: An overview of adverse events and treatment approaches. *Plastic and Aesthetic Nursing, 35*(1), 13–32. https://doi.org/10.1097/PSN.0000000000000087

Gyöngy, M., Kiss, N., & Czajkowska, J. (2024). Best practices for the use of high-frequency ultrasound to guide filler injection in the temple, forehead, and glabella. *Cosmetics, 11*(3), 345.

Haykal, D., Cartier, H., Benzaquen, M., Damiani, G., & Habib, S. M. (2023). The growing importance of ultrasonography in cosmetic dermatology: An update after the 23rd IMCAS Annual World Congress (2022). *Journal of Cosmetic Dermatology, 22*(1), 222–225. https://doi.org/10.1111/jocd.15503

Hong, G.-W., Wan, J., Choi, W., & Yi, K.-H. (2025). An expert guide to anatomy-based filler injection for the temple: Techniques and clinical insights. *Life, 15*(2), 266. https://doi.org/10.3390/life15020266

Hussein, R. S., Bin Dayel, S., Abahussein, O., & El-Sherbiny, A. A. (2025). Influences on skin and intrinsic aging: Biological, environmental, and therapeutic insights. *Journal of Cosmetic Dermatology, 24*(2), e16688.

International Trade Administration. (2024). *Thailand aesthetics medicine*. U.S. Department of Commerce. Retrieved April 13, 2025, from https://www.trade.gov/market-intelligence/thailand-aesthetics-medicine

Jitaree, B., Phumyoo, T., Uruwan, S., Jiirasutat, N., Pratoomthai, B., & Tansatit, T. (2021). Clinical implications of the arterial supplies and their anastomotic territories in the nasolabial region for avoiding arterial complications during soft tissue filler injection. *Clinical Anatomy, 34*(4), 581–589. https://doi.org/10.1002/ca.23617

Lamb, J. P., & Surek, C. C. (2018). The temple and the brow. In *Facial volumization* (Chapter 4). Georg Thieme Verlag KG. https://doi.org/10.1055/b-0037-146355

Lee, W., Moon, H. J., Kim, M. S., Cheon, G. W., & Yang, E. J. (2022a). Pre-injection ultrasound scanning for treating temporal hollowing. *Journal of Cosmetic Dermatology, 21*(6), 2420–2425. https://doi.org/10.1111/jocd.14471

Lee, E., Kim, S.-B., & Yi, K.-H. (2023). Implications for improving the safety of deep temporal injections: Anatomical study of the deep temporal artery with application to filler procedures. *Aesthetic Plastic Surgery, 47*(5), 589–599. https://doi.org/10.1007/s00266-023-03341-y

Li, X., Wei, Z., & Zhao, H. (2023). The application of high-frequency ultrasound imaging in identifying facial soft tissues and filler materials in the temporal region. *Journal of Cosmetic Dermatology, 22*(10), 4276–4284.

Ma, J., Wen, Y., Zhao, R., & Qiu, H. (2024). Comparison of facial soft tissue thickness among Chinese and Caucasian adults using CT. *Forensic Science International, 330*, 111285.

Meyer, G. C. O., & Quarta, V. M. (2023). The effects of aging on the intramuscular connective tissue. *International Journal of Molecular Sciences, 23*(19), 11061.

Moss, C. J., Mendelson, B. C., & Taylor, G. I. (2000). Surgical anatomy of the ligamentous attachments in the temple and periorbital regions. *Plastic and Reconstructive Surgery, 105*(4), 1475–1490.

Nikolis, A., Enright, K. M., Troupis, T., Koutsilieris, M., Stratigos, A. J., Rigopoulos, D., & Cotofana, S. (2022). Topography of the deep temporal arteries and implications for performing safe aesthetic injections. *Journal of Cosmetic Dermatology, 21*(2), 608–614. https://doi.org/10.1111/jocd.14672

Phumyoo, T., Tansatit, T., & Rachkeaw, N. (2014). The soft tissue landmarks to avoid injury to the facial artery during filler and neurotoxin injection at the nasolabial region. *The Journal of Craniofacial Surgery, 25*(5), 1885–1889. https://doi.org/10.1097/SCS.0000000000001003

Sigrist, R., Desyatnikova, S., Chammas, M. C., & Vasconcelos-Berg, R. (2024). Best practices for the use of high-frequency Doppler ultrasound to guide aesthetic filler injections — Part 1: Upper third of the face. *Diagnostics, 14*(16), Article 1718. https://doi.org/10.3390/diagnostics14161718

Sihag, R. K., Gupta, S. K., Sahni, S., & Aggarwal, A. (2020). Frontotemporal branch of the facial nerve and fascial layers in the temporal region: A cadaveric study to define a safe dissection plane. *Neurology India, 68*(6), 1313–1320.

Tansatit, T., Apinuntrum, P., & Phetudom, T. (2017). A dark side of cannula injections: How arterial wall perforations and emboli occur. *Aesthetic Plastic Surgery, 41*(1), 221–227. https://doi.org/10.1007/s00266-016-0725-7

Velthuis, P. J., Jansen, O., Schelke, L. W., Moon, H. J., Kadouch, J., Ascher, B., & Cotofana, S. (2021). A guide to Doppler ultrasound analysis of the face in cosmetic medicine. Part 1: Standard positions. *Aesthetic Surgery Journal, 41*(11), NP1621–NP1632. https://doi.org/10.1093/asj/sjaa410

Wong, Q. Y. A., & Chew, F. T. (2021). Defining skin aging and its risk factors: A systematic review and meta-analysis. *Scientific Reports, 11*, Article 22075.

Zaree, A., Dev, S., Yaseen Khan, I., Arain, M., Rasool, S., Khalid Rana, M. A., Kanwal, K., Bhagat, R., Prachi, F., Puri, P., Varrassi, G., Kumar, S., Khatri, M., & Mohamad, T. (2023). Cardiac rehabilitation in the modern era: Optimizing recovery and reducing recurrence. *Cureus, 15*(9), e46006. https://doi.org/10.7759/cureus.46006

Zhang, X., Li, Y., & Li, Z. (2024). Aging and homeostasis of the hypodermis in the age-related skin decline. *Cell Death & Disease, 15*, Article 181.

Zhao, J., Xu, Y., Wang, J., Lu, Z., & Qi, K. (2023). 3-dimensional analysis of hard- and soft-tissue symmetry in a Chinese population. *BMC Oral Health, 23*, Article 432. https://doi.org/10.1186/s12903-023-03163-z

Zhao, Y., Huang, X., Fu, Z., Zhang, L., Jin, T. T., Pan, L., Lai, F., Wang, J., Wu, S., & Chen, C. (2023). The anatomy study of temporal region based on ultrasound investigation: A spatial structure study. *The Journal of Craniofacial Surgery, 34*(5), 1570–1574. https://doi.org/10.1097/SCS.0000000000009236